

Table 1

	raw powder			sintering condition	properties of sintered body					
	AlN powder		Sm2O3 mol%		chemical analysis data			Sm2O3 converted content mol %	Al2O3 calculated content mol %	Sm2O3/ Al2O3 molar ratio
	type	Oxygen content weight%			O content wt%	Sm content wt%	C content wt%			
example 1	A	0.97	0.23	1800	1.19	1.53	0.029	0.214	0.831	0.258
example 2	A	0.97	0.12	1800	0.94	0.69	0.029	0.096	0.721	0.133
example 3	A	0.97	0.35	1800	1.23	1.87	0.034	0.263	0.821	0.320
example 4	A	0.97	0.06	1900	0.81	0.35	0.030	0.048	0.653	0.074
example 5	A	0.97	0.23	1900	0.52	0.43	0.028	0.059	0.389	0.152
example 6	B	0.87	0.12	1800	0.85	0.70	0.030	0.097	0.641	0.151
example 7	B	0.87	0.23	1800	1.06	1.43	0.030	0.200	0.729	0.274
example 8	C	0.44	0.06	1800	0.67	0.37	0.038	0.051	0.528	0.097
example 9	C	0.44	0.12	1800	0.71	0.74	0.040	0.102	0.513	0.199
example 10	D	1.20	0.35	1800	1.44	1.84	0.037	0.259	1.013	0.256
comparative example 1	A	0.97	0.02	1800	0.80	0.16	0.031	0.022	0.669	0.033
comparative example 2	A	0.97	0.06	1700	0.85	0.37	0.031	0.051	0.685	0.075
comparative example 3	A	0.97	0.58	1800	1.52	3.55	0.034	0.508	0.856	0.594
comparative example 4	B	0.87	0.35	1800	1.19	2.17	0.033	0.306	0.745	0.410
comparative example 5	C	0.44	0.23	1800	0.82	1.50	0.039	0.209	0.507	0.412

Table 2

properties of sintered body									
	open porosity %	bulk density g/cm ³	resistivity 25°C Ω · cm	resistivity 300 °C Ω · cm	activation energy eV	bending strength MPa	thermal conductivity W/mK	average grain diameter of AlN	crystalline phase (excluding AlN)
example 1	0.05	3.30	6E+10	1E+08	0.35	370	101	4	SmAlO ₃ , SmAl ₁₁ O ₁₈
example 2	0.04	3.28	4E+11	6E+08	0.35	344	95	4	SmAlO ₃ , SmAl ₁₁ O ₁₈
example 3	0.02	3.33	6E+11	1E+09	0.34	396	107	4	SmAlO ₃ , SmAl ₁₁ O ₁₈
example 4	0.05	3.27	9E+10	2E+08	0.33	406	89	6	SmAlO ₃ , SmAl ₁₁ O ₁₈
example 5	0.04	3.27	1E+11	2E+08	0.34	399	120	6	SmAlO ₃ , SmAl ₁₁ O ₁₈
example 6	0.04	3.28	2E+11	2E+08	0.37	458	98	4	SmAlO ₃ , SmAl ₁₁ O ₁₈
example 7	0.02	3.30	3E+11	4E+08	0.35	448	105	4	SmAlO ₃ , SmAl ₁₁ O ₁₈
example 8	0.07	3.27	8E+11	9E+08	0.37	399	93	4	SmAlO ₃ , SmAl ₁₁ O ₁₈
example 9	0.04	3.28	7E+11	9E+08	0.36	388	100	4	SmAlO ₃ , SmAl ₁₁ O ₁₈
example 10	0.08	3.34	7E+10	1E+08	0.35	364	102	4	SmAlO ₃ , SmAl ₁₁ O ₁₈
comparative example 1	0.04	3.26	4E+15	1E+11	1.13*	387	96	4	SmAl ₁₁ O ₁₈
comparative example 2	0.07	3.27	3E+15	5E+10	1.14*	368	97	2	SmAlO ₃ , SmAl ₁₁ O ₁₈
comparative example 3	0.05	3.36	1E+15	9E+10	1.18*	444	121	4	SmAlO ₃
comparative example 4	0.02	3.32	3E+14	1E+11	0.88*	440	111	4	SmAlO ₃
comparative example 5	0.03	3.30	9E+13	1E+09	1.01*	436	110	4	SmAlO ₃

★ temperature range for measurement : 1 5 0 ~ 4 0 0 °C

Fig. 1 is a graph showing the temperature dependency of volume resistivity of the body according to example 1. Fig.1 also shows each graph of temperature dependency of each sintered body according to each of example 2 and comparative examples 6 to 8. The activation energy is a slope of a graph showing temperature dependency of volume resistivity. The activation energy was 0.34 eV (25 to 300 °C) in the example 1, 0.35 eV (25 to 300 °C) in the example 2, 1.0 eV (150 to 400 °C) in the comparative example 6, 0.71 eV (25 to 170 °C) in the comparative example 7 and 0.69 eV (25 to 170 °C) in the comparative example 8. The inventive sintered bodies have the activation energies considerably lower than those of the sintered bodies of comparative examples.

When a range of volume resistivity of $1\text{E}+12$ to $1\text{E}+8$ (1×10^{12} to 1×10^8) $\Omega \cdot \text{cm}$ is suitable for a substrate of an electrostatic chuck, the sintered body of the example 1 satisfies this range from -30 to 300 °C. Similarly, the body of the example 2 satisfies the range from 10 to 400 °C, the comparative example 6 satisfies it from 150 to 400 °C and the comparative examples 7 and 8 satisfy it from 0 to 120 °C. The sintered body according to the invention may be applied to an electrostatic chuck in a temperature range considerably wider than that of a prior sintered body.

The strength, thermal conductivity and mean diameter of AlN grains were described in table 2. Particularly, the sintered body according to the invention has a strength of 370 MPa, which was higher than those of the comparative examples 7 and 8.

Fig. 2 shows peak profile of X-ray diffraction measurement. According to Fig. 2, AlN phase (JCPDS No. 25-1133) and SmaAlO_3 phase (JCPDS No. 46-0394) were identified. Another phase was observed at $2\theta = 19, 20, 22^\circ$ or the like. The peak positions of the another phase correspond with